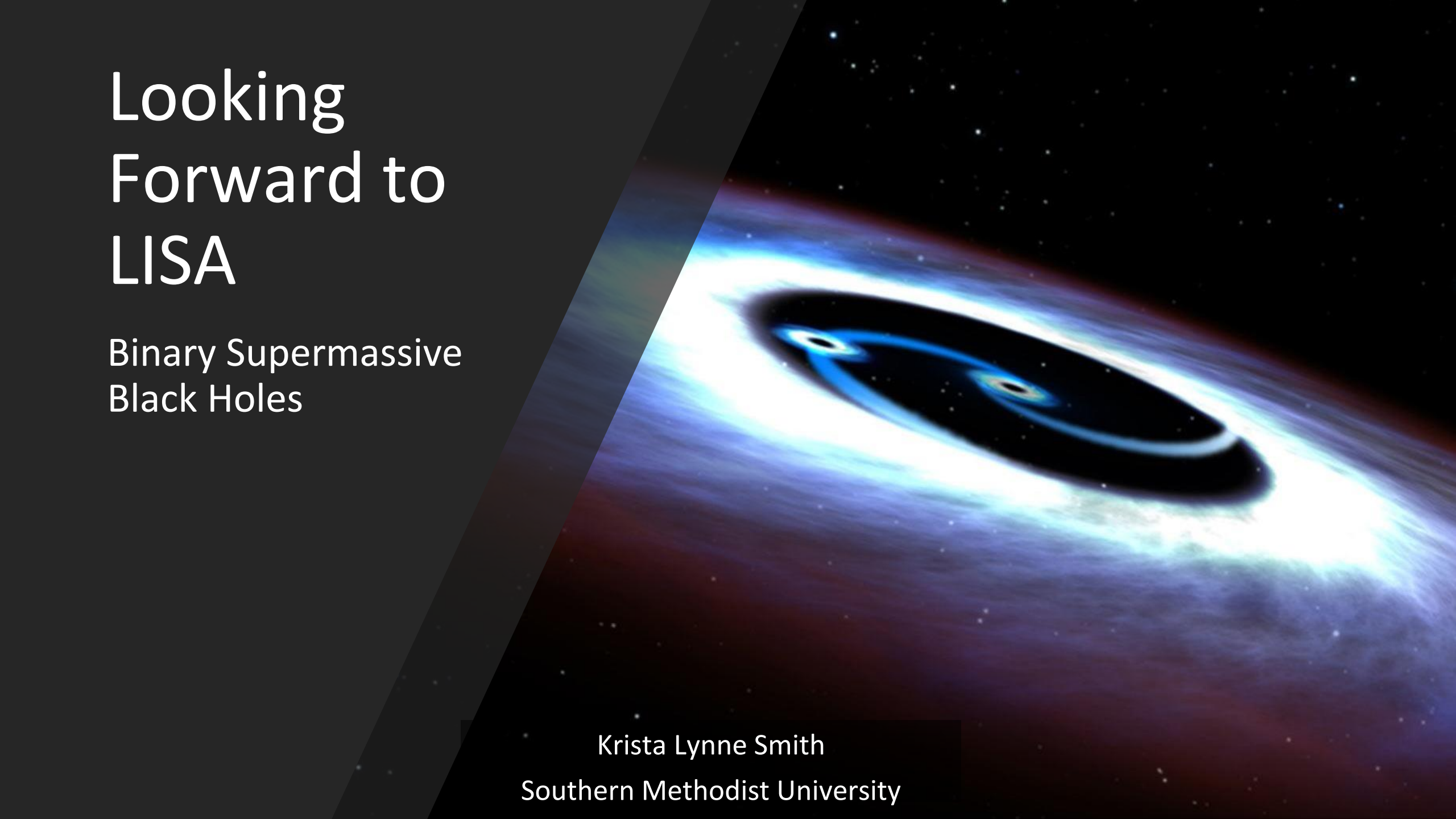
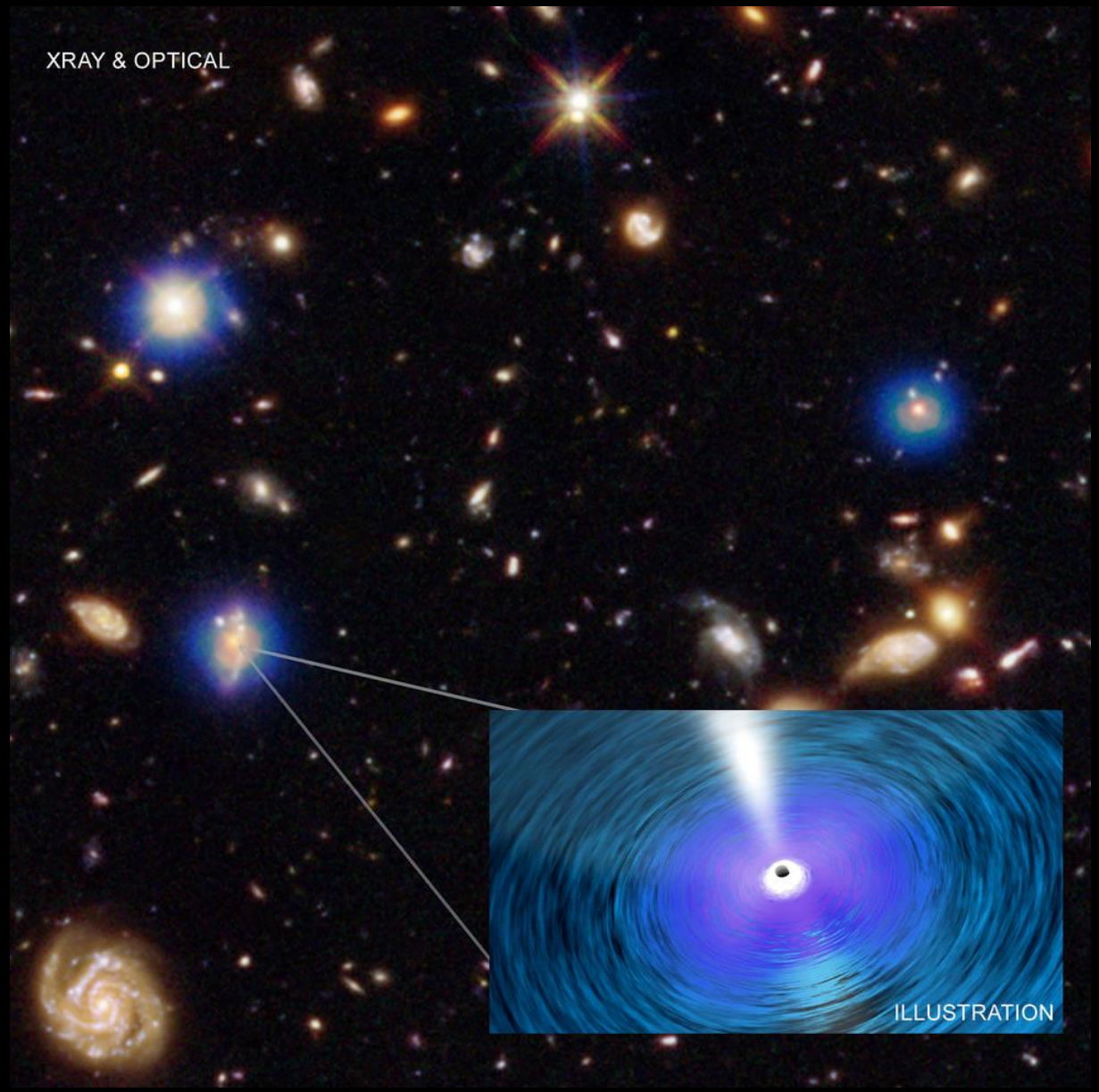
Looking Forward to LISA

Binary Supermassive Black Holes



Krista Lynne Smith

Southern Methodist University

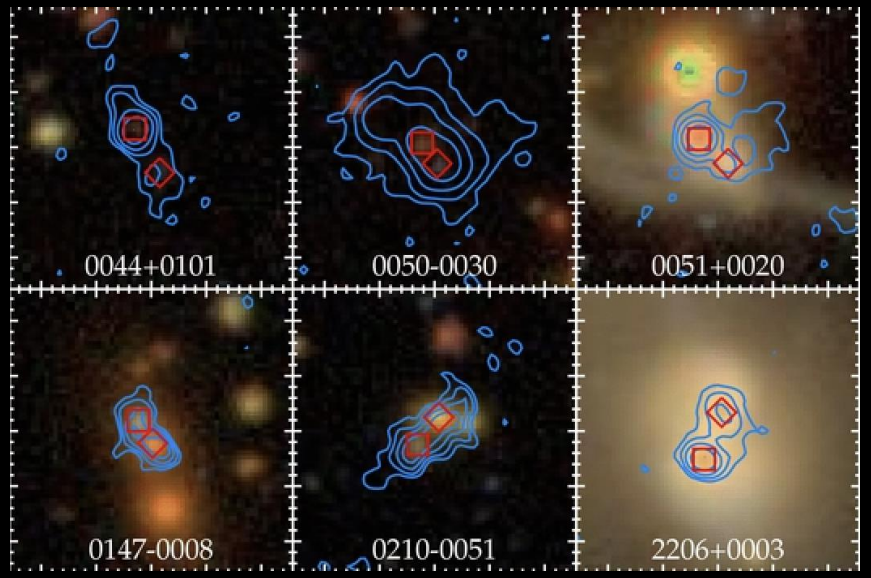


NASA

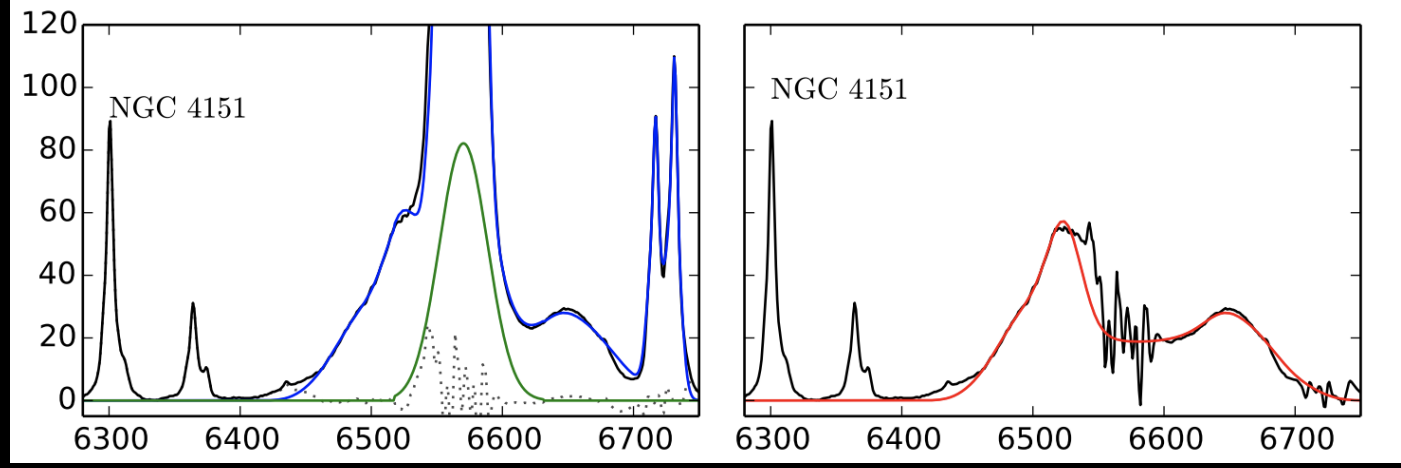
The vast majority of galaxies have a central supermassive black hole.

$10^6 – 10^9\ M_{sun}$

They should be EVERYWHERE.

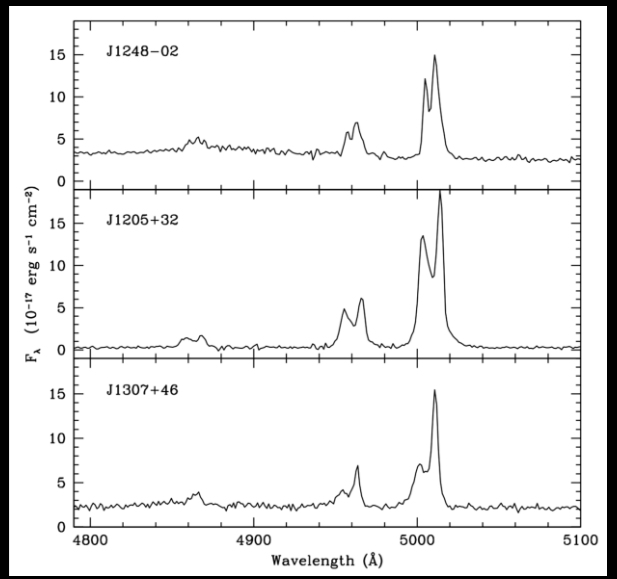


Fu et al. 2015

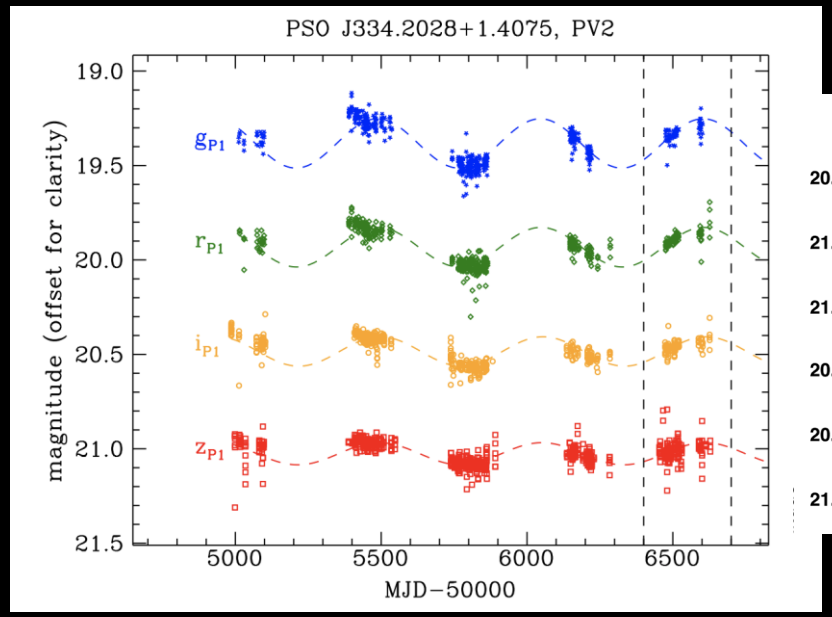


Storchi-Bergmann et al. 2016

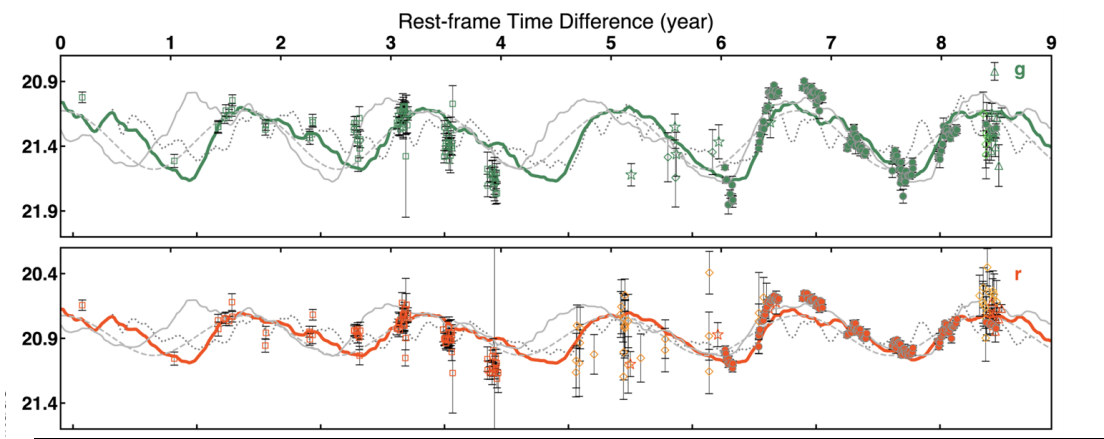
But they AREN'T.



Smith et al. (2010)



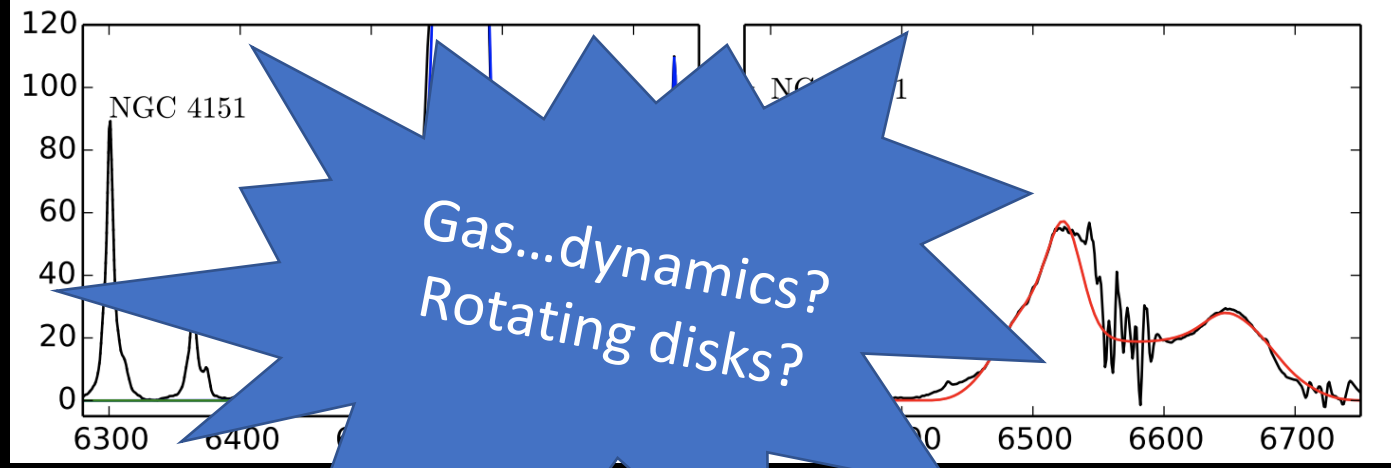
Liu et al. 2016



Liao et al. 2020

Lobes, Imaging Artifacts, Stellar Contaminants

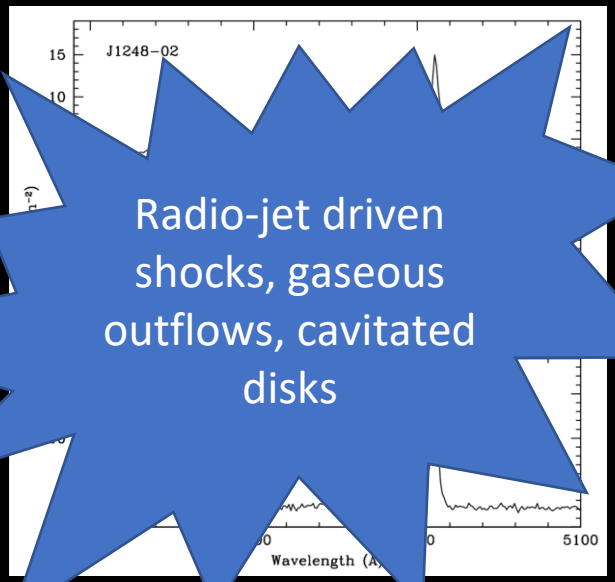
Fu et al. 2015



Gas…dynamics? Rotating disks?

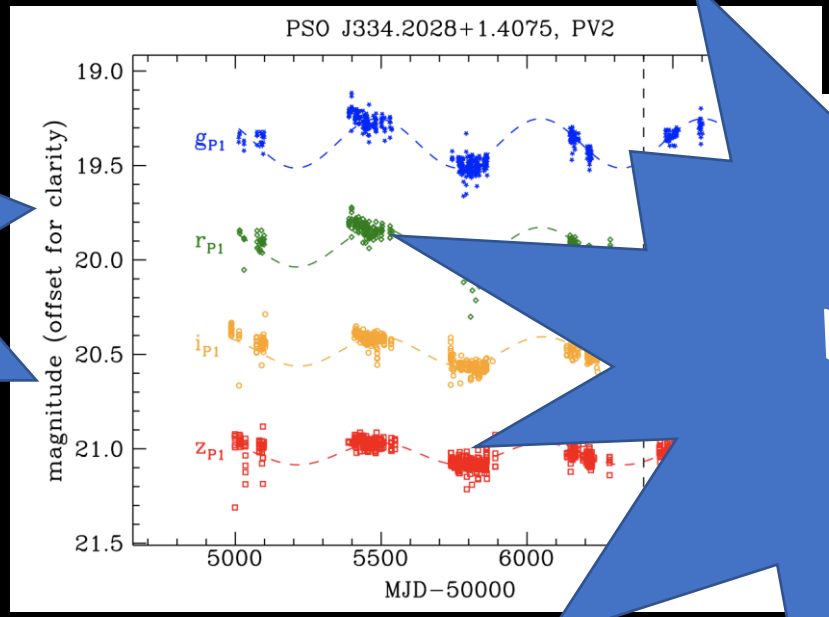
Storchi-Bergmann et al. 2016

But they AREN'T.



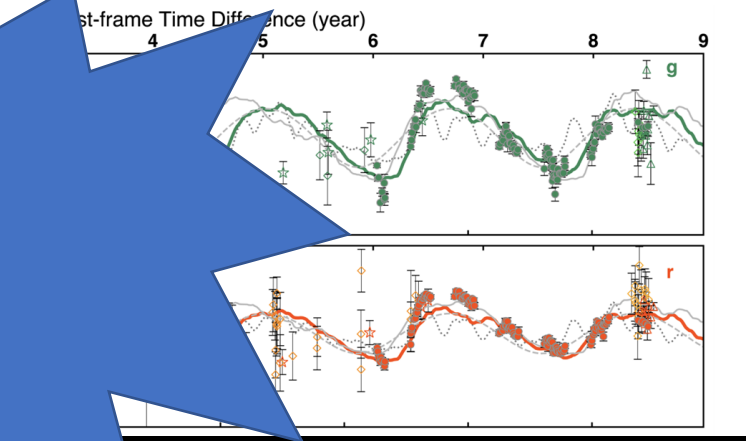
Radio-jet driven shocks, gaseous outflows, cavitated disks

Smith et al. (2010)

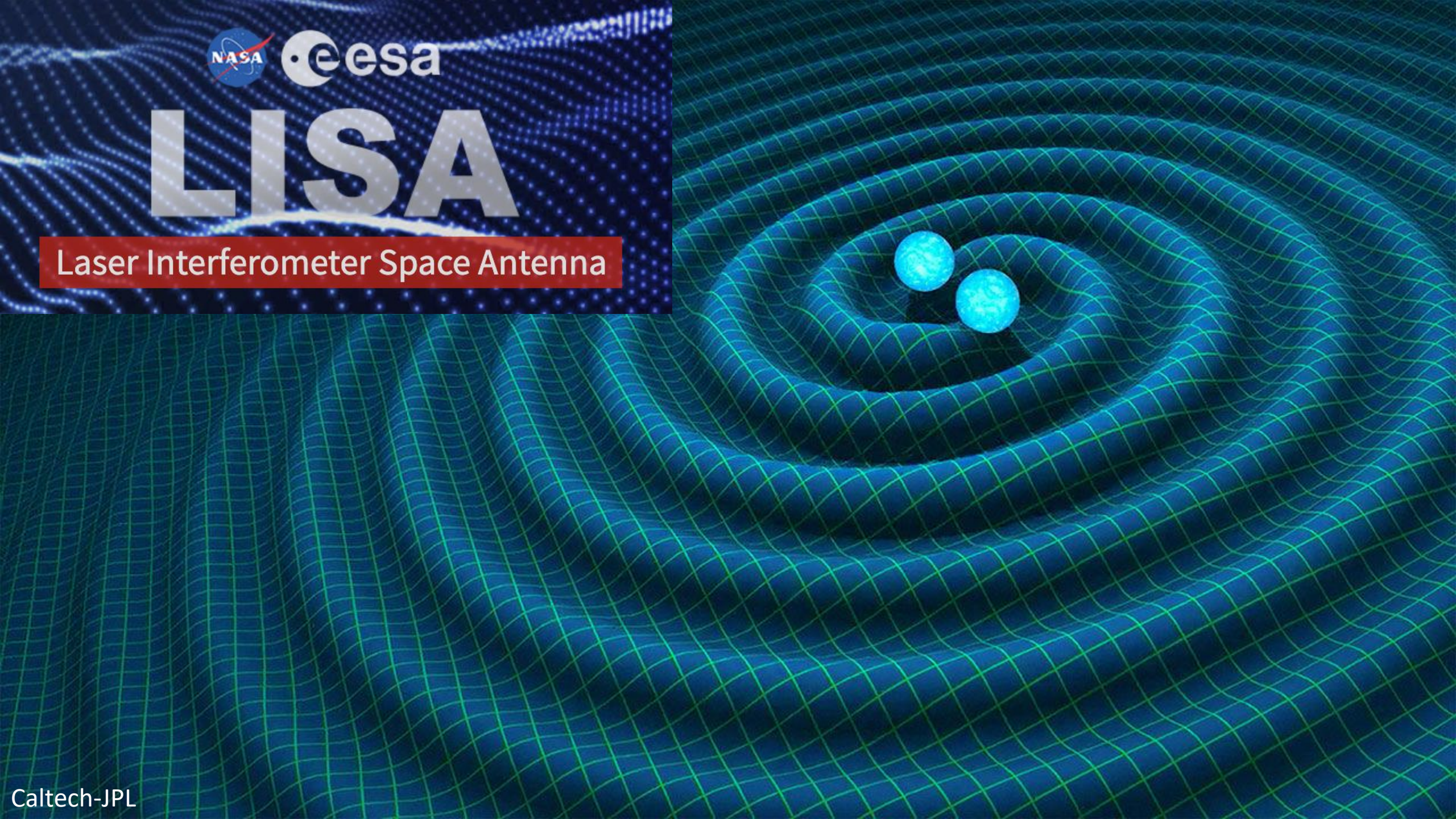


Red Noise Variability

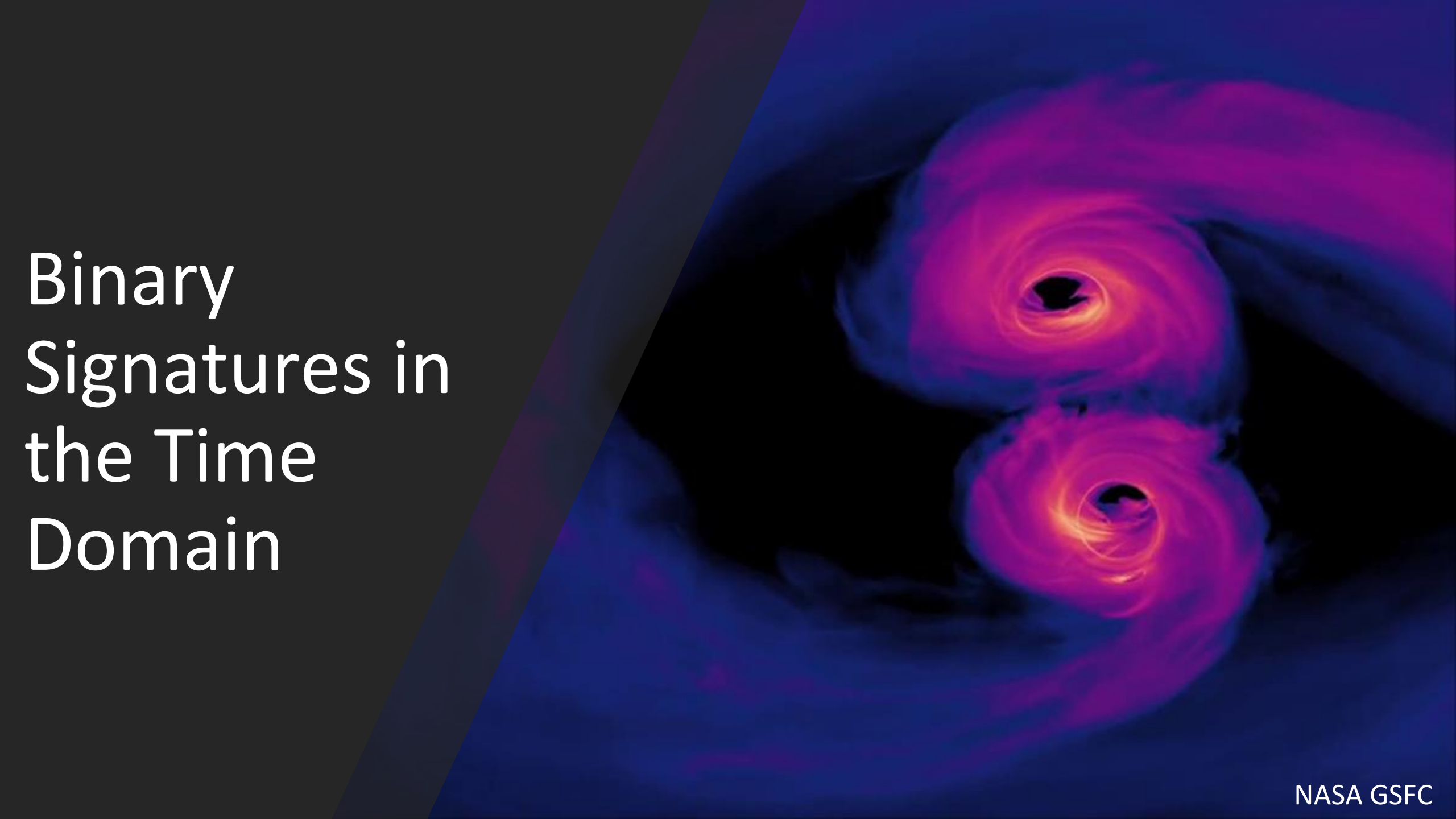
Liu et al. 2016



Liao et al. 2020

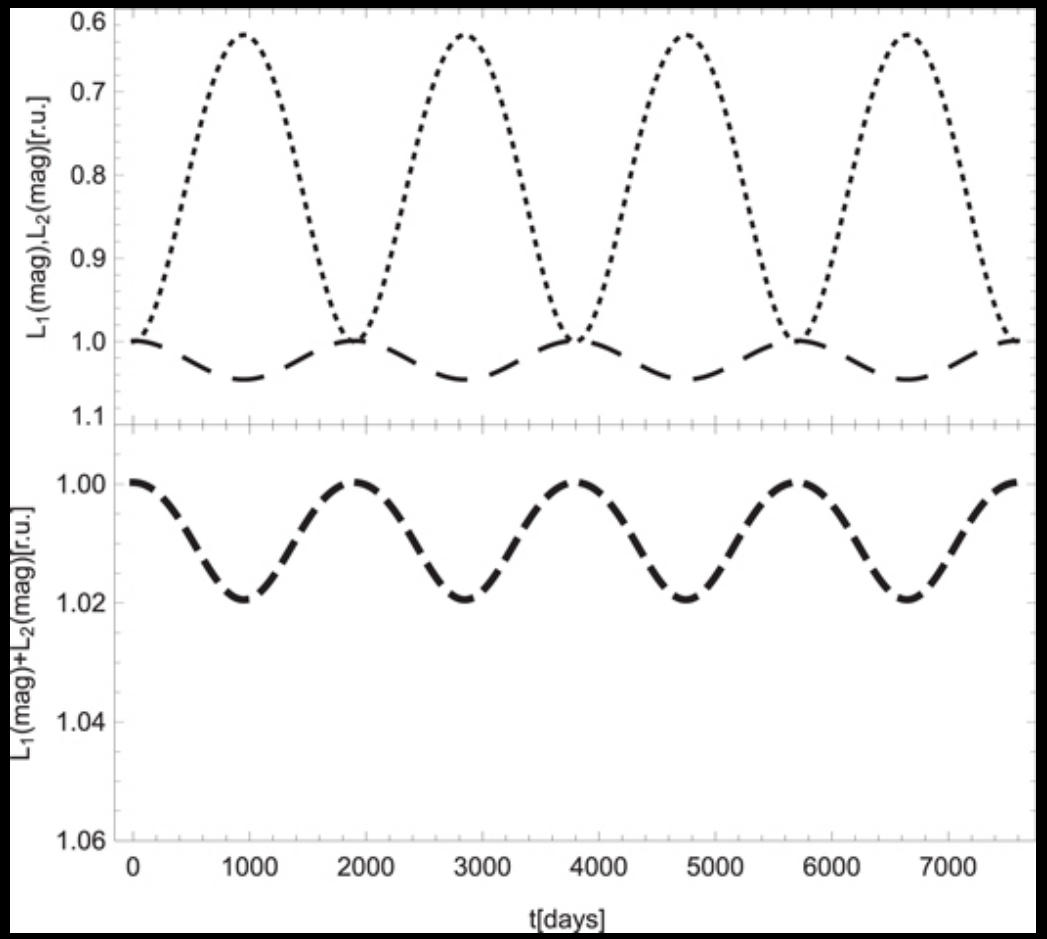

NASA
esa
LISA
Laser Interferometer Space Antenna
Caltech-JPL

Binary Signatures in the Time Domain

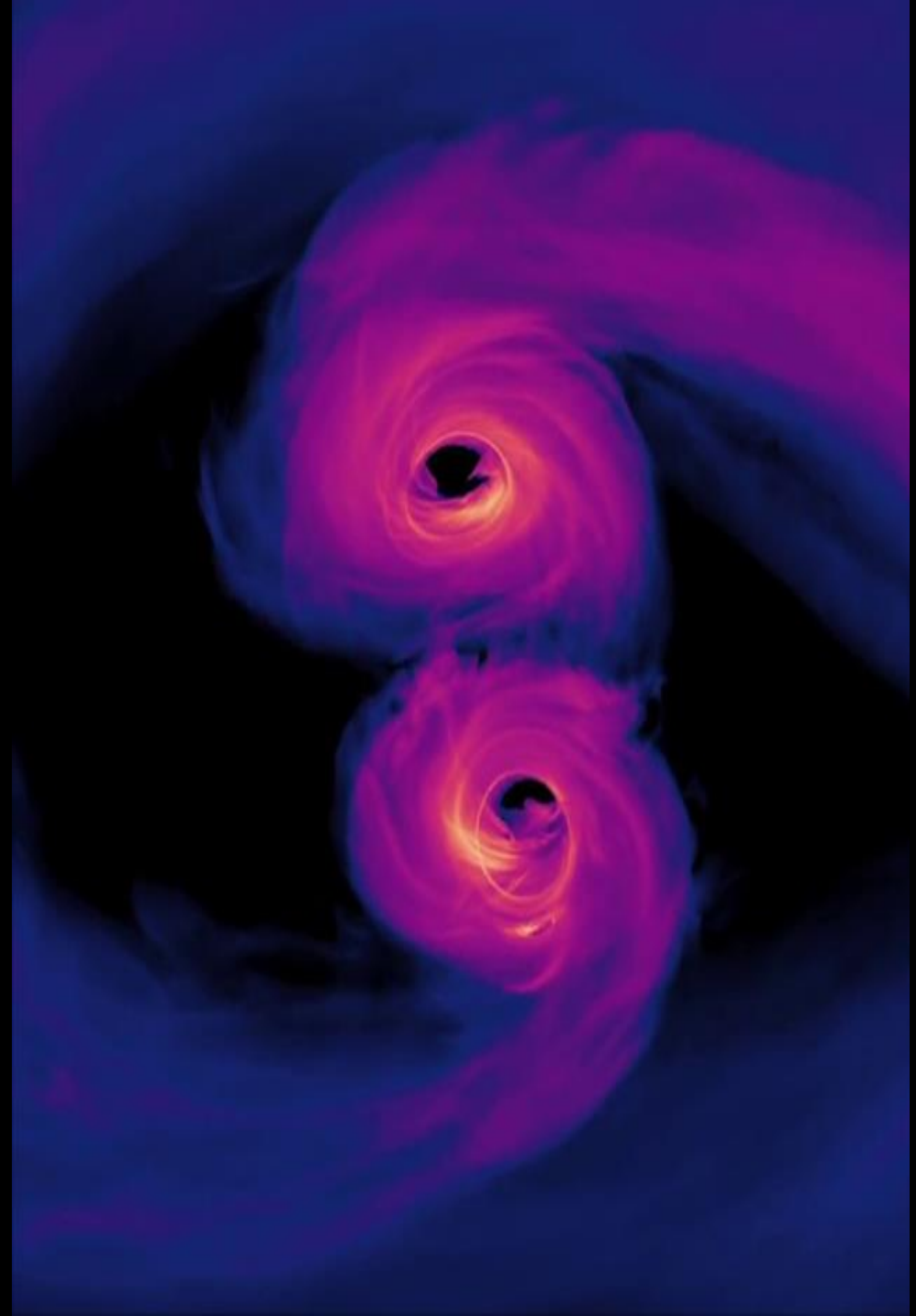


NASA GSFC

Light Curve Periodicity

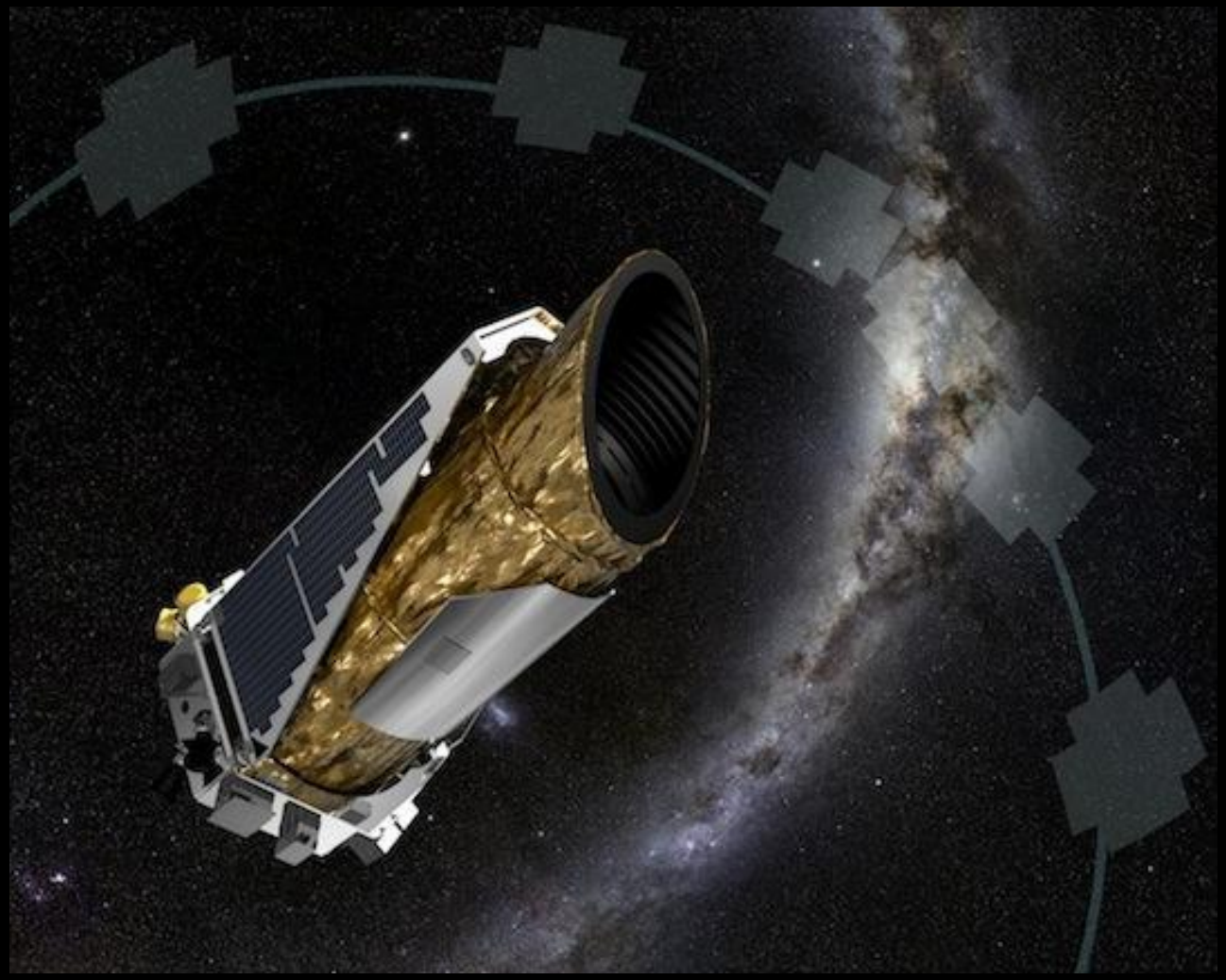


Kovacevic et al. (2019)

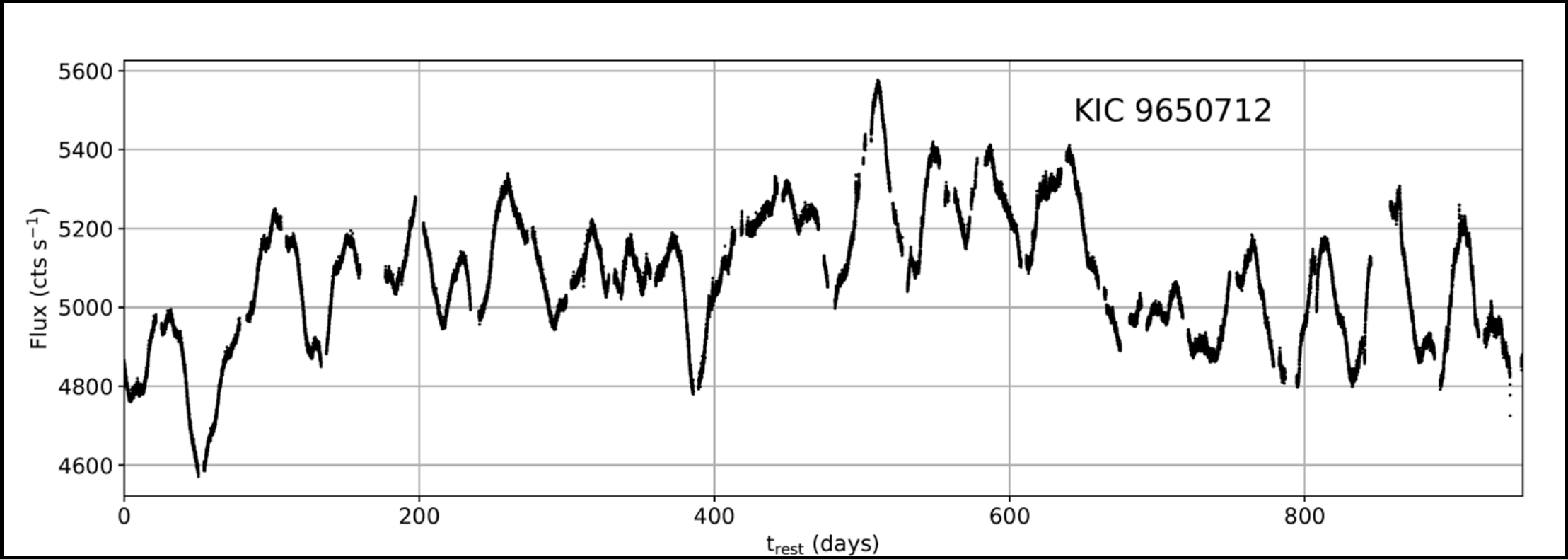


Better Light Curves!

- Even sampling
- Long baselines
- Extreme photometric precision



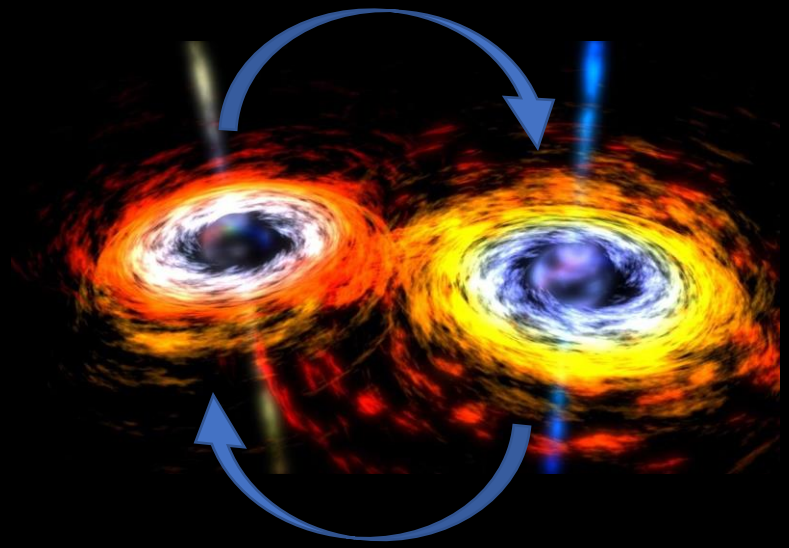
Quasi-periodicity in a *Kepler* AGN

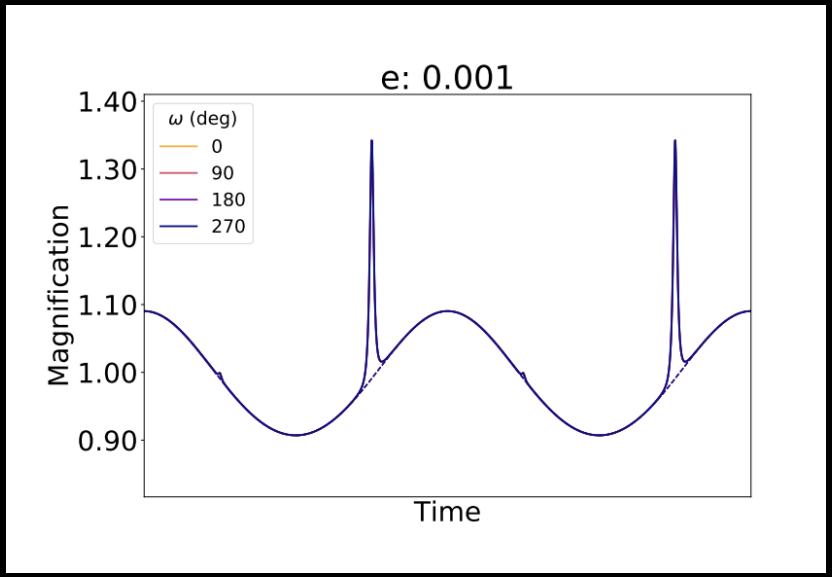


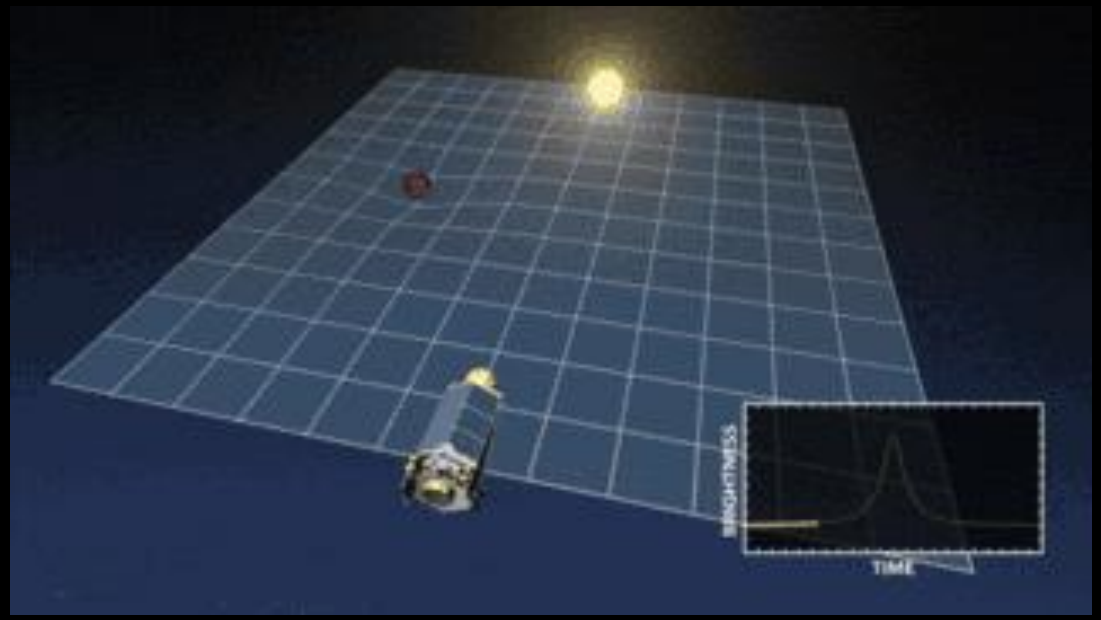
Smith et al. (2018b)

Quasi-periodic oscillations can also be used to *weigh* black holes, another important data point for LISA.

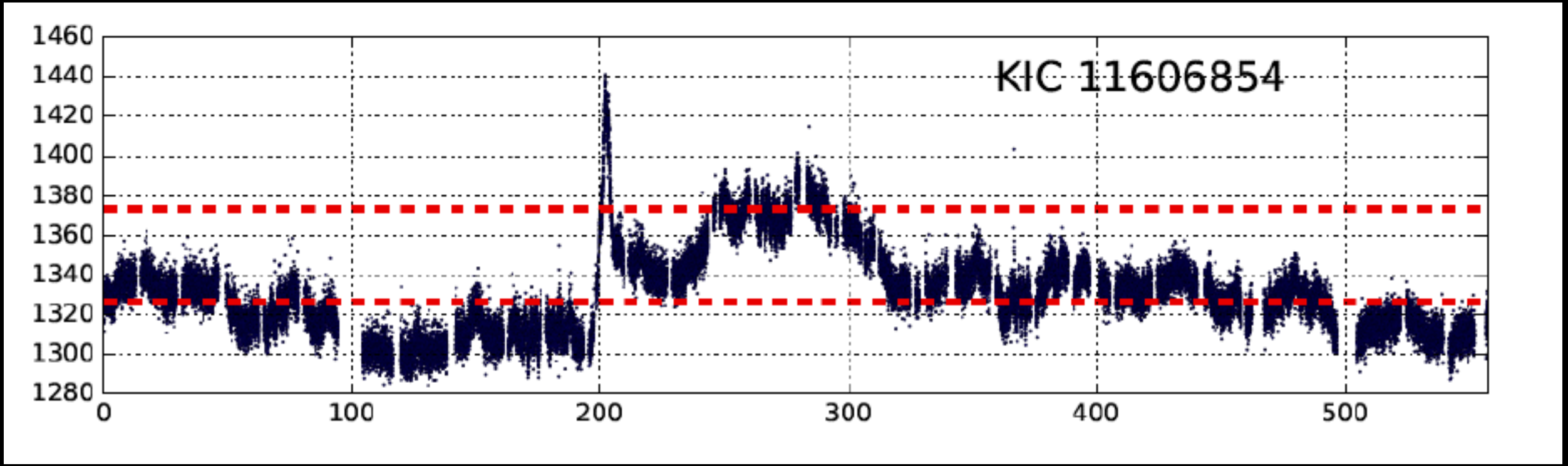
Gravitational Self-Lensing Flares





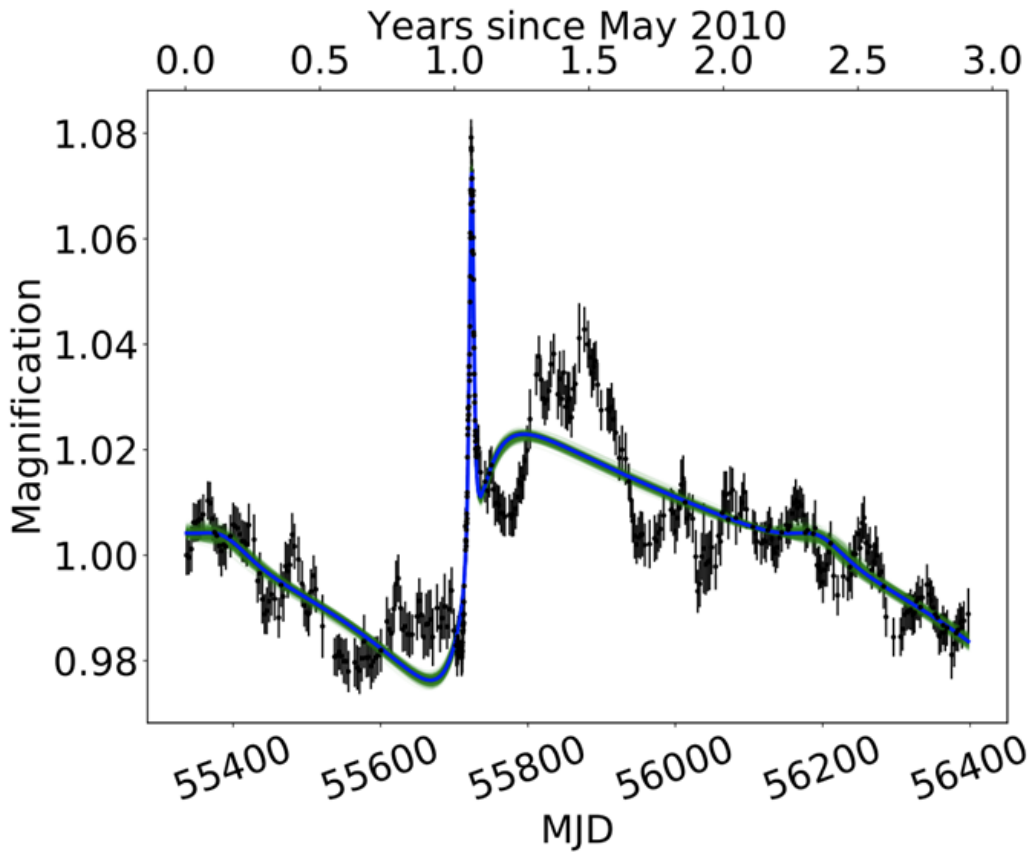


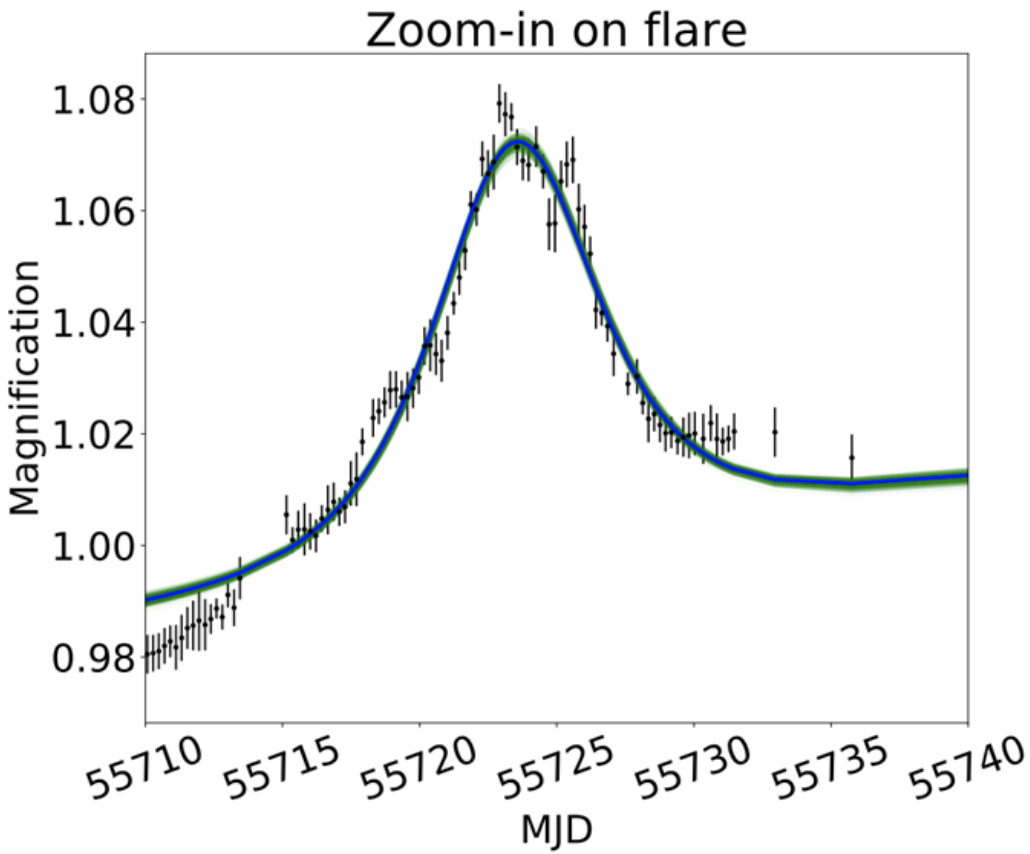
Gravitational Self-Lensing Flares



Smith et al. (2018a)

KIC 11606854: A Self-Lensing Candidate



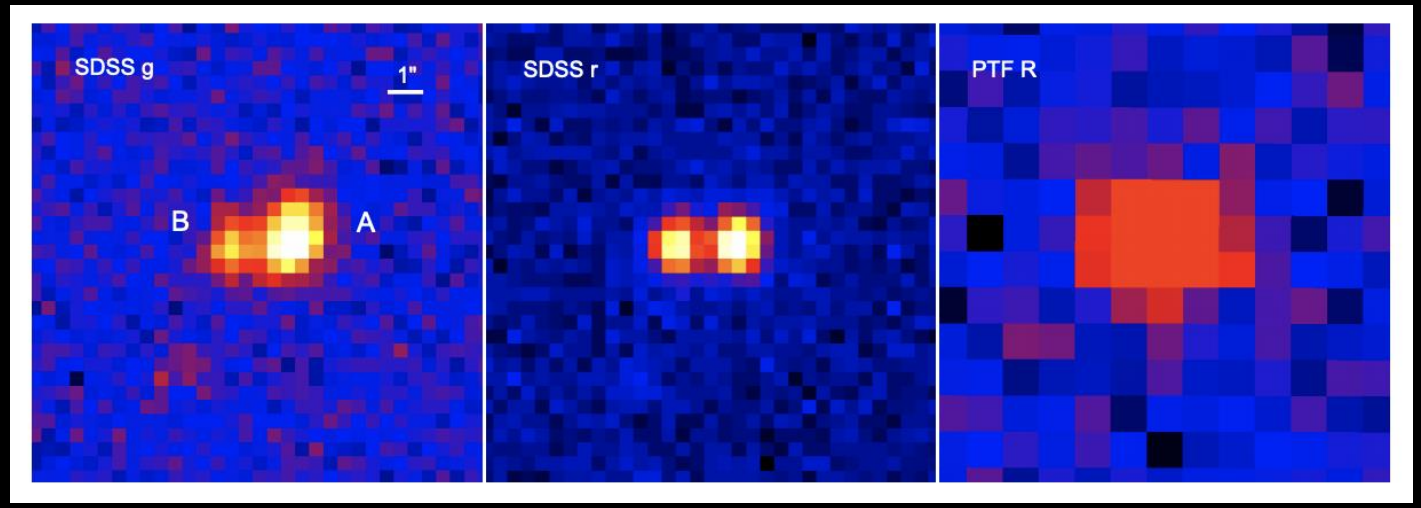


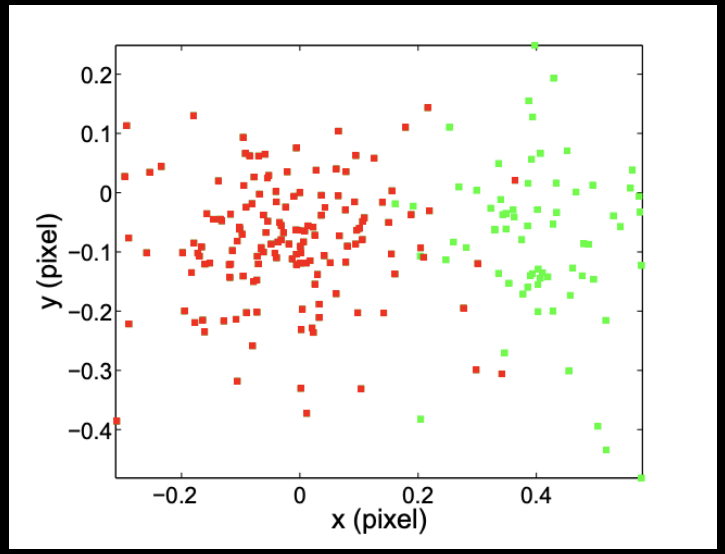
Hu, D'Orazio, Smith (2020)

Lots, lots MORE light curves!

- 20 billion galaxies
- 10-year baseline
- 6 color filters

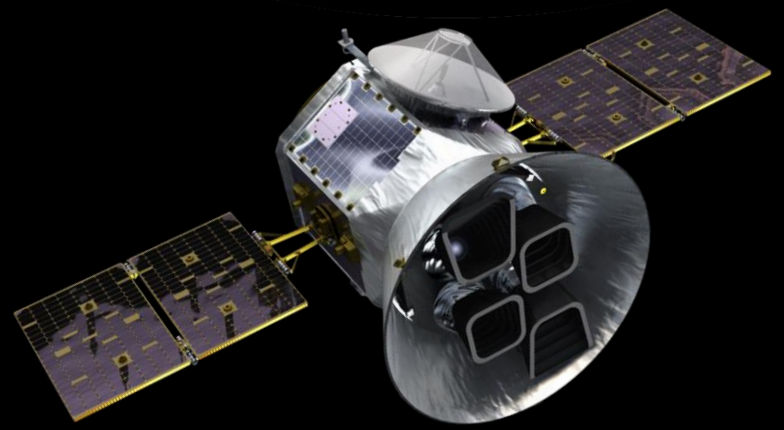
Image Centroid Shifts

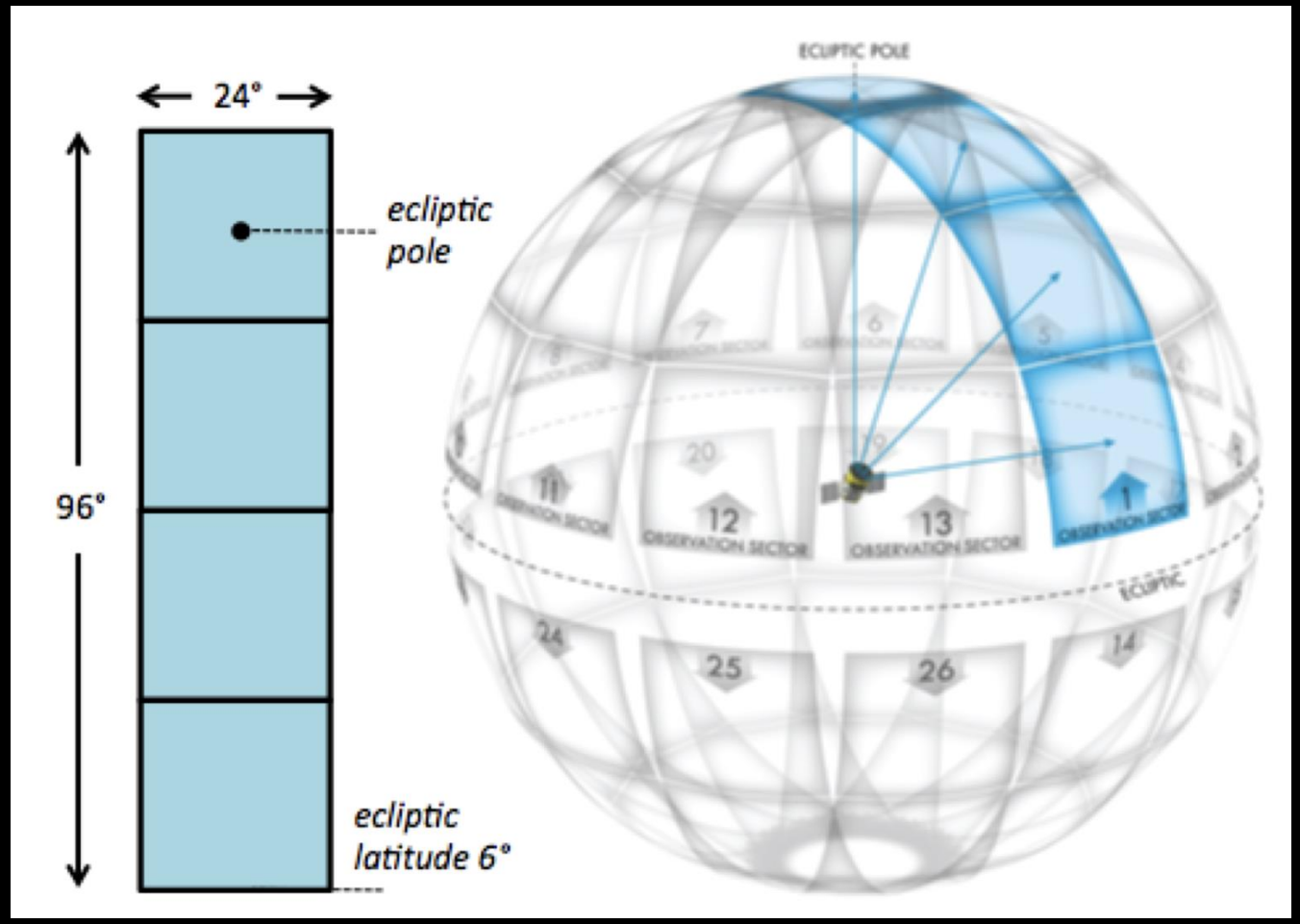




Liu 2016

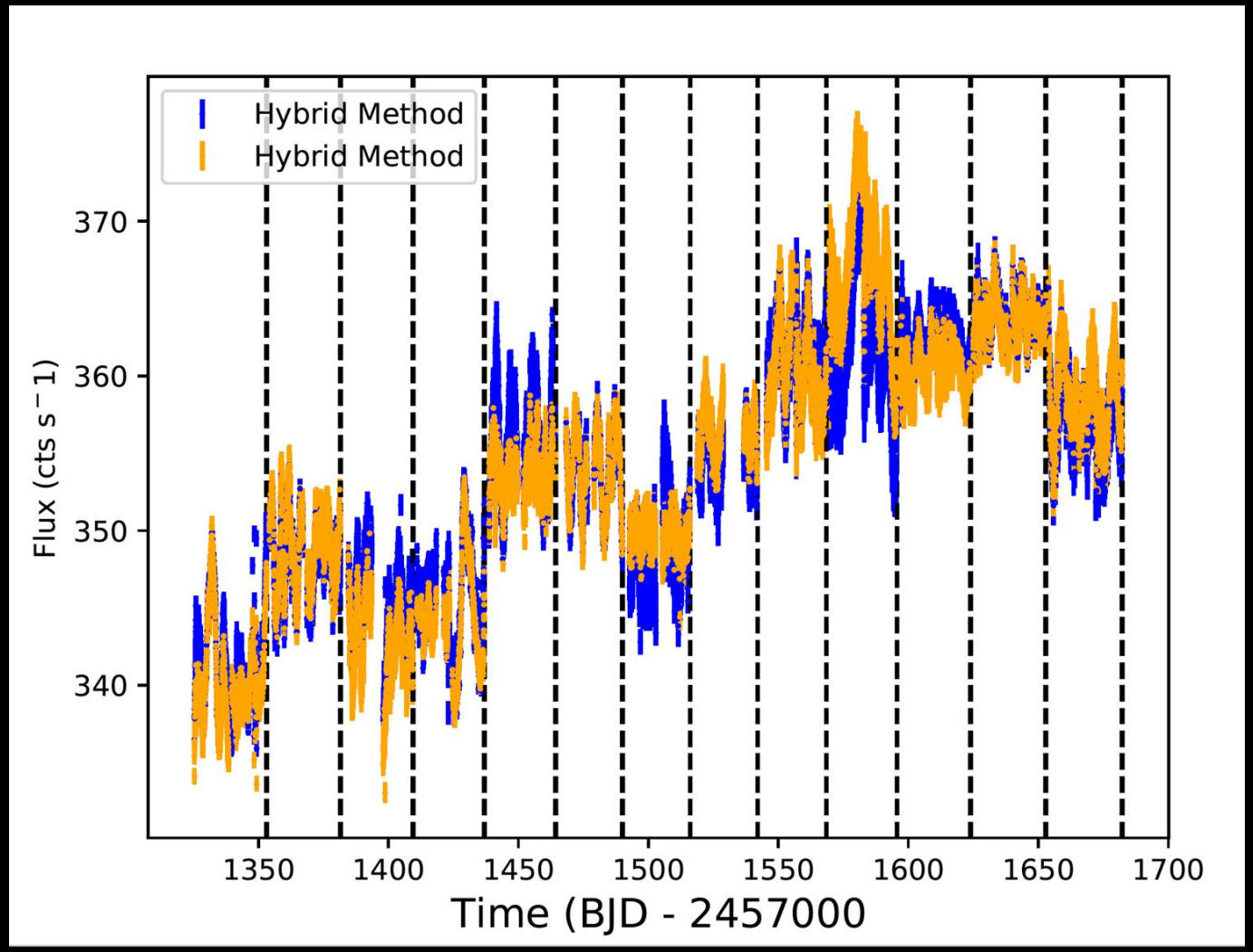
Lots, lots more, and better, light curves!





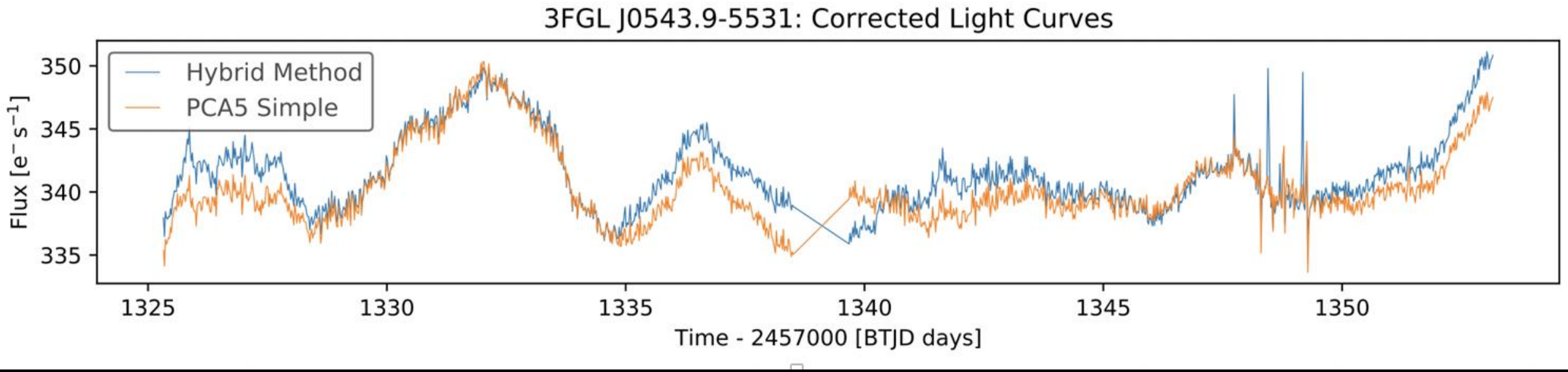
Ricker et al. (2014), Sullivan et al. (2015)

TESS AGN Light Curves



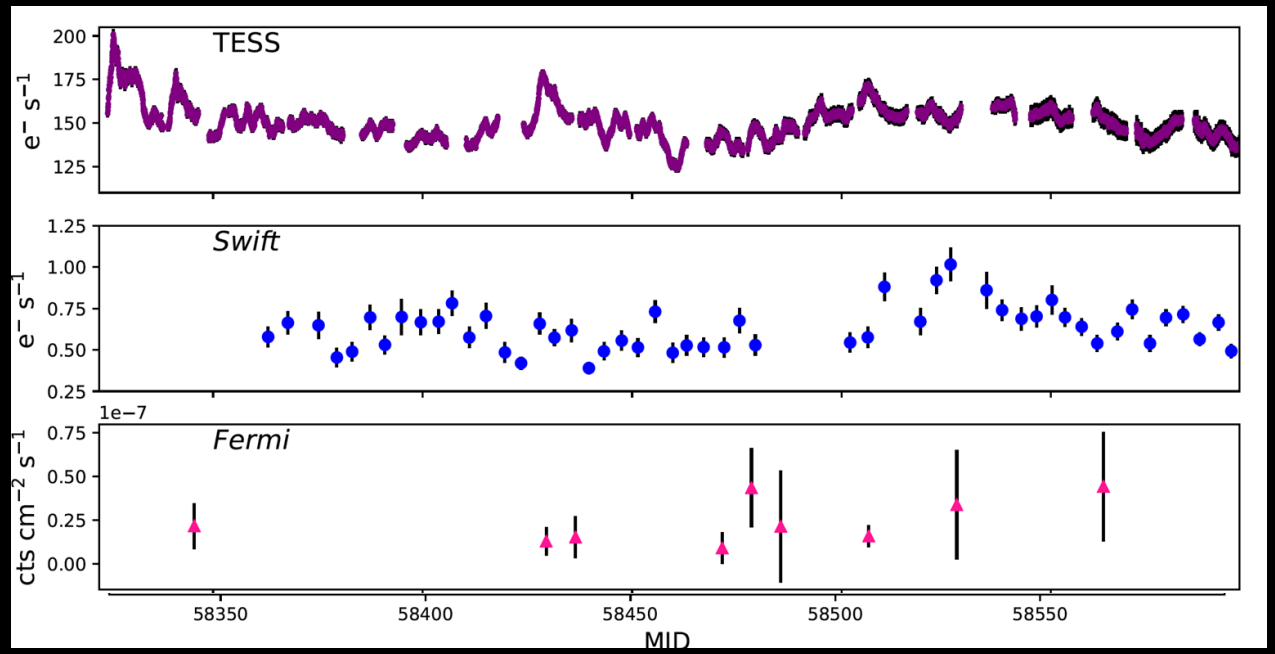
Smith 2021, in prep

TESS AGN Light Curves

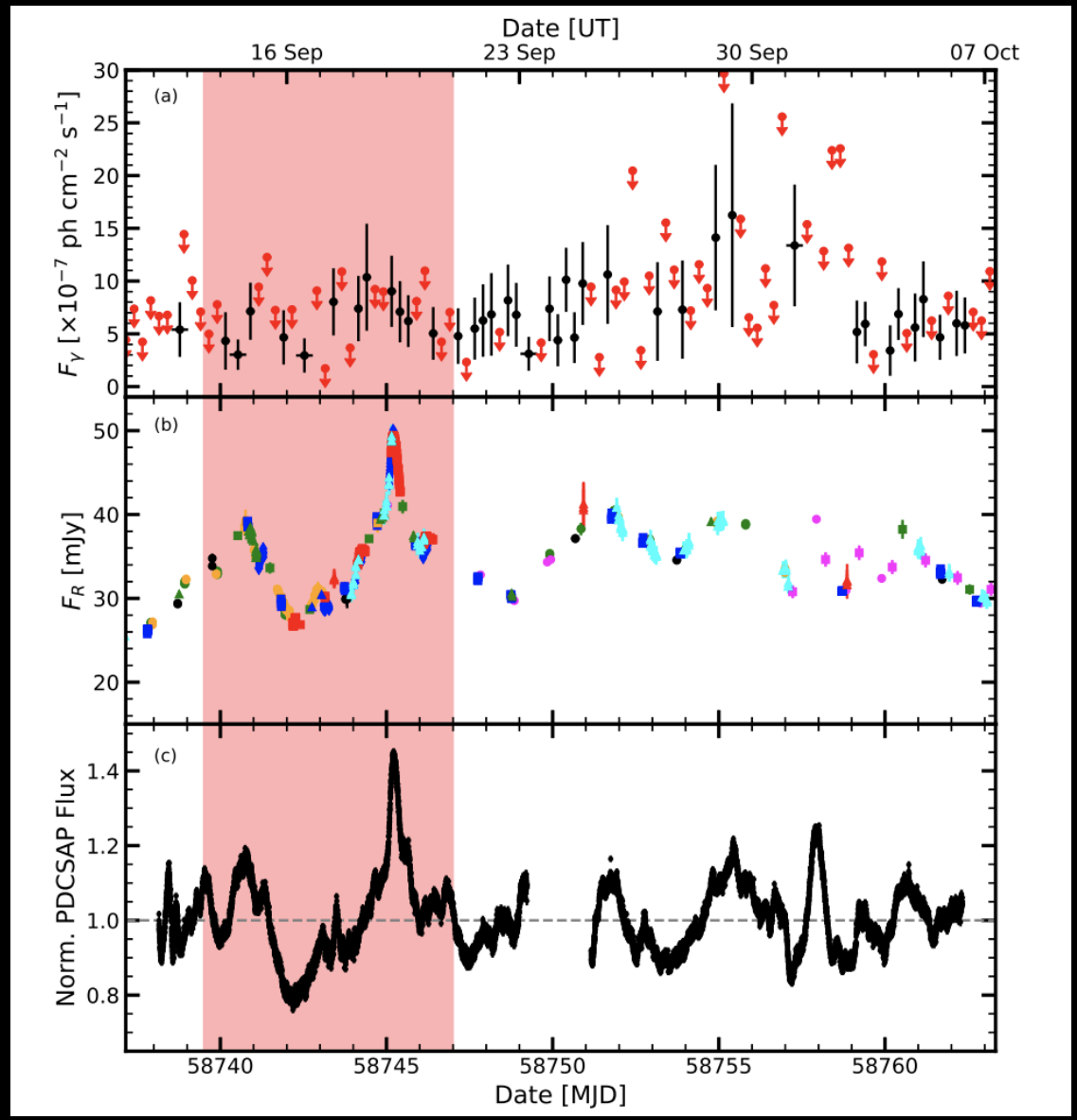


Smith 2021, in prep

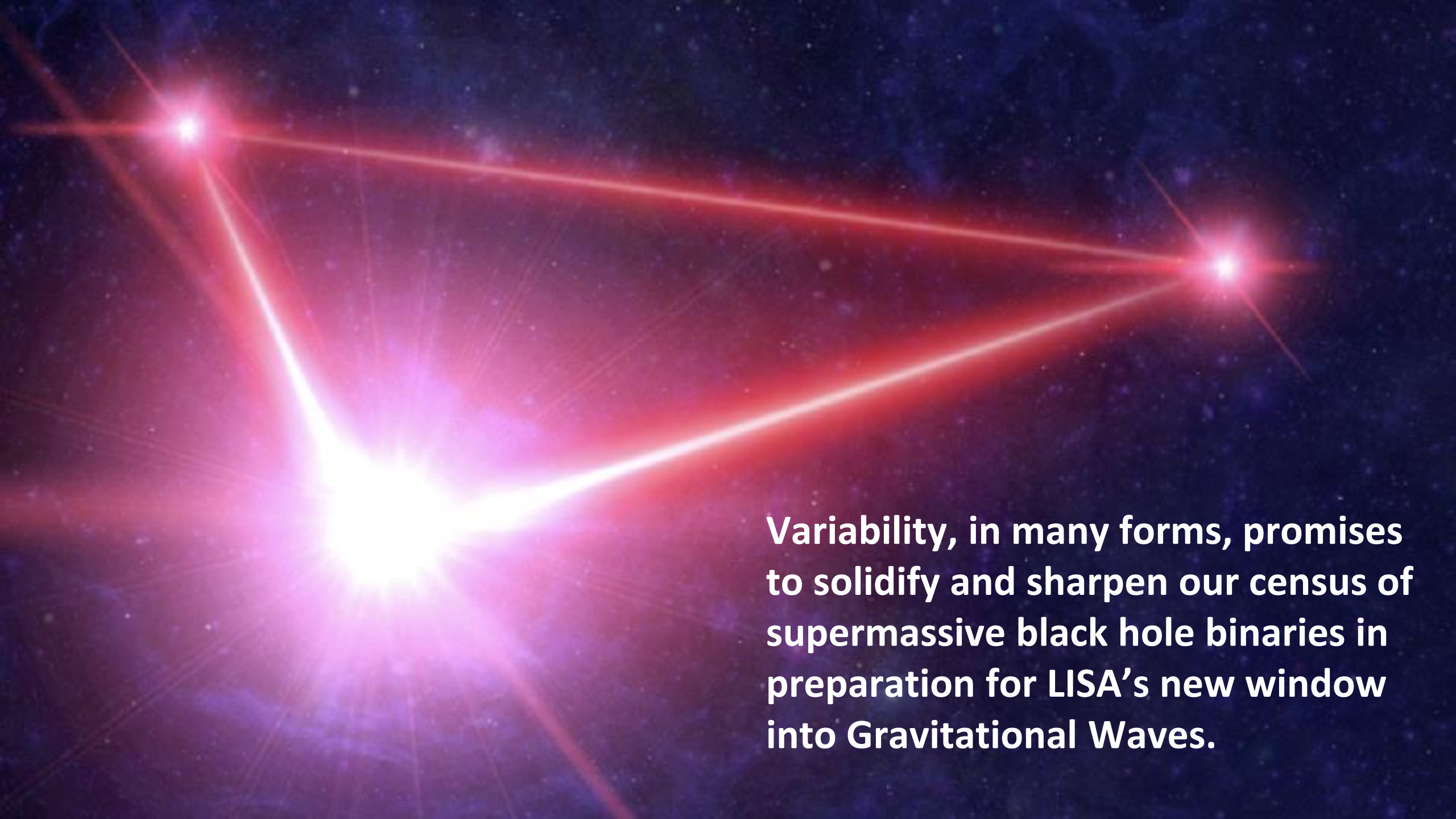
TESS AGN Light Curves



Smith 2021, in prep



Weaver, Smith ++ 2020

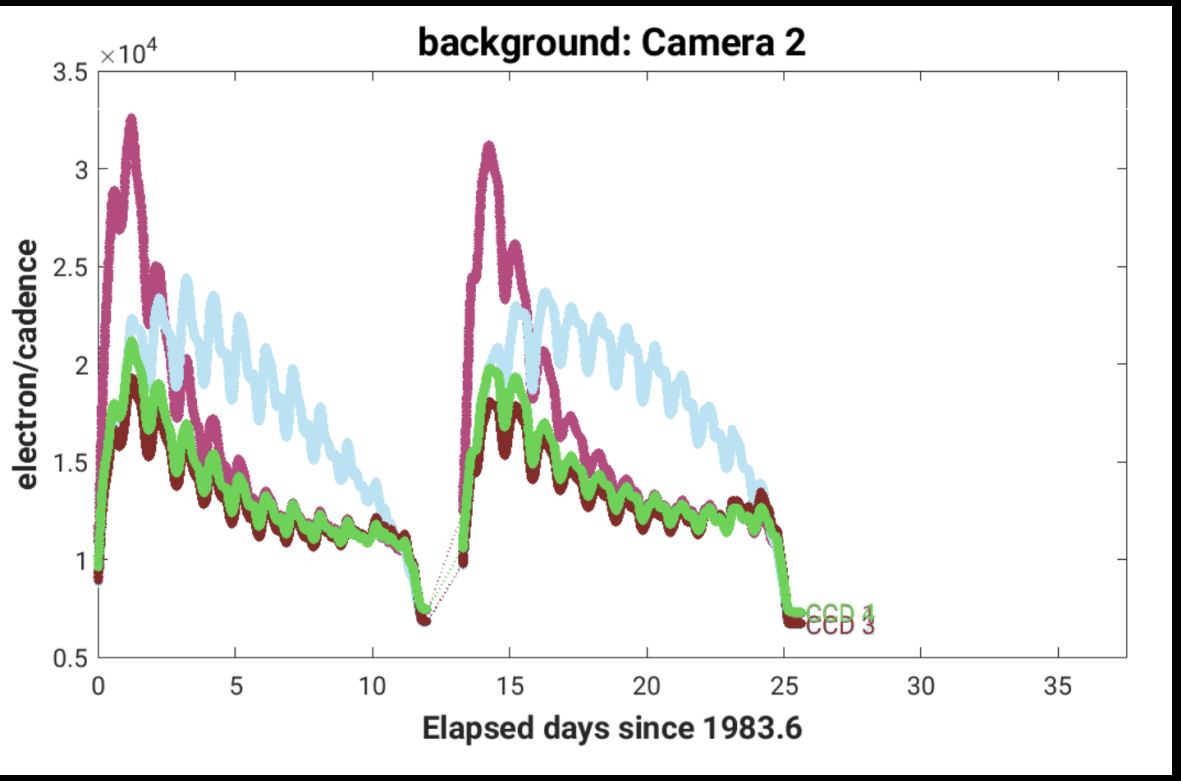

Variability, in many forms, promises to solidify and sharpen our census of supermassive black hole binaries in preparation for LISA’s new window into Gravitational Waves.

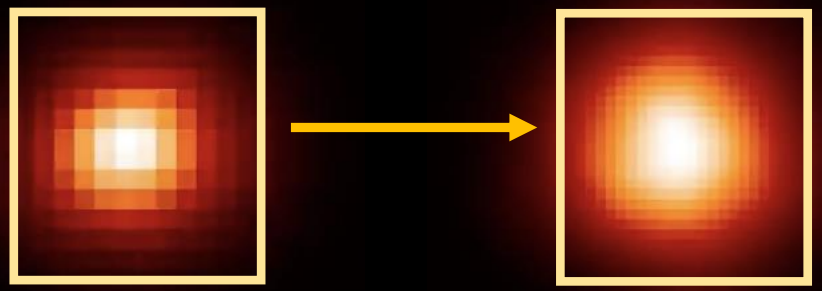
Systematics: TESS

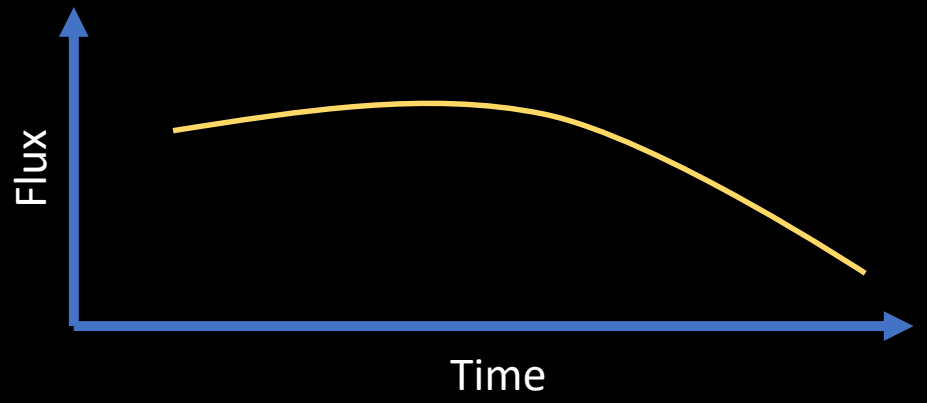
- Repurposing spacecraft data: not an easy task!

Systematic dominate.

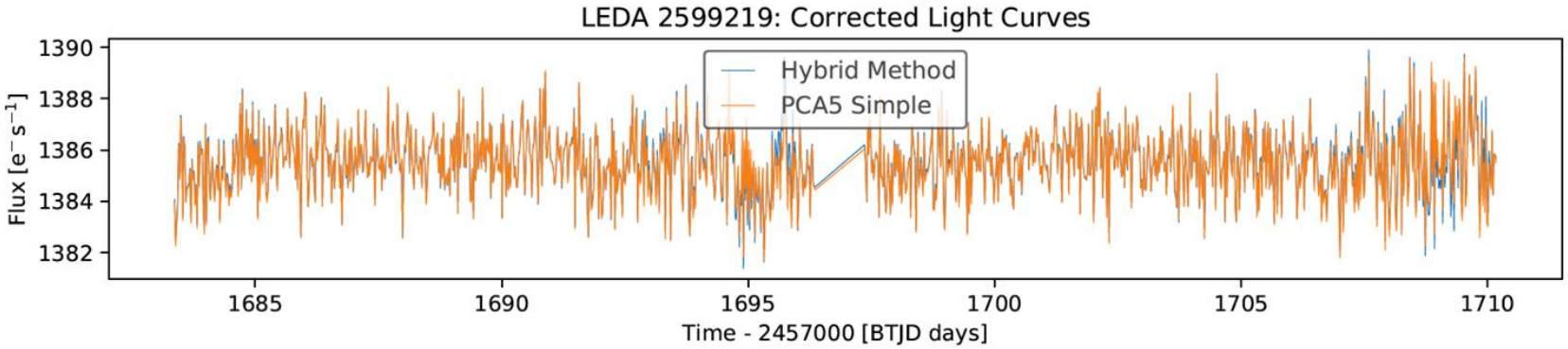
-Scattered light from the sun and moon
-Electronic noise
-Thermal fluctuations

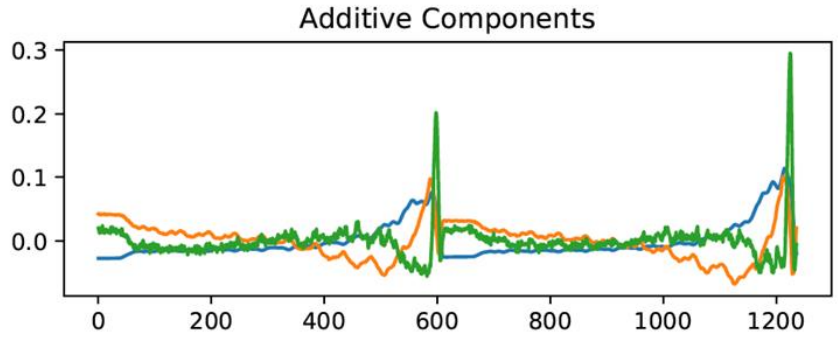


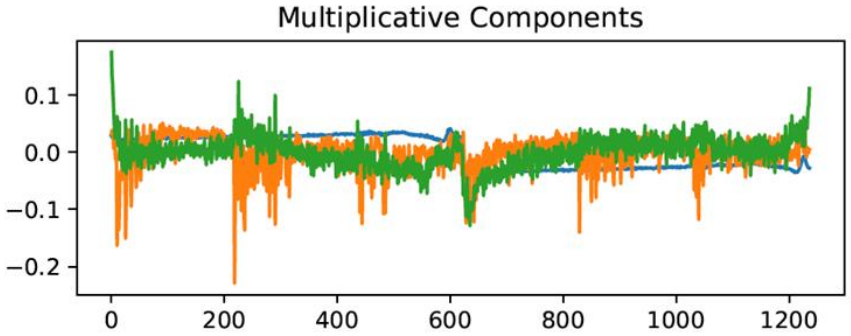


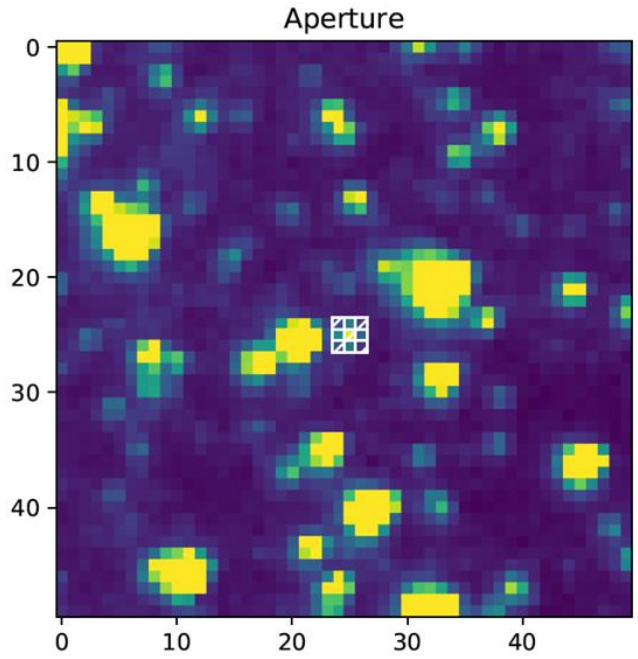


Systematics: TESS

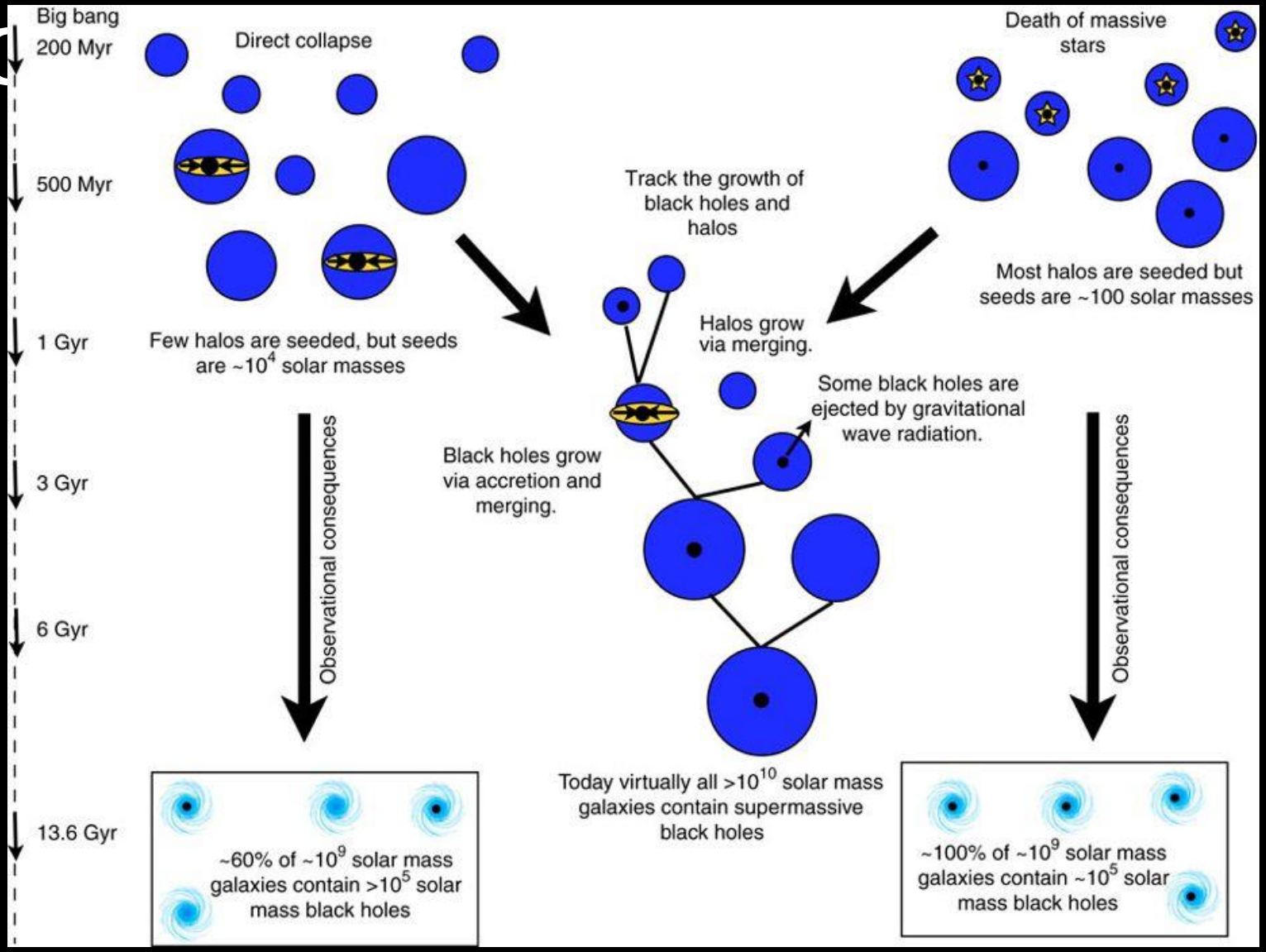








The origins of supermassive black ho



Greene 2012

Occupation Fraction of massive black holes in dwarf galaxies

Seeds of supermassive black holes.